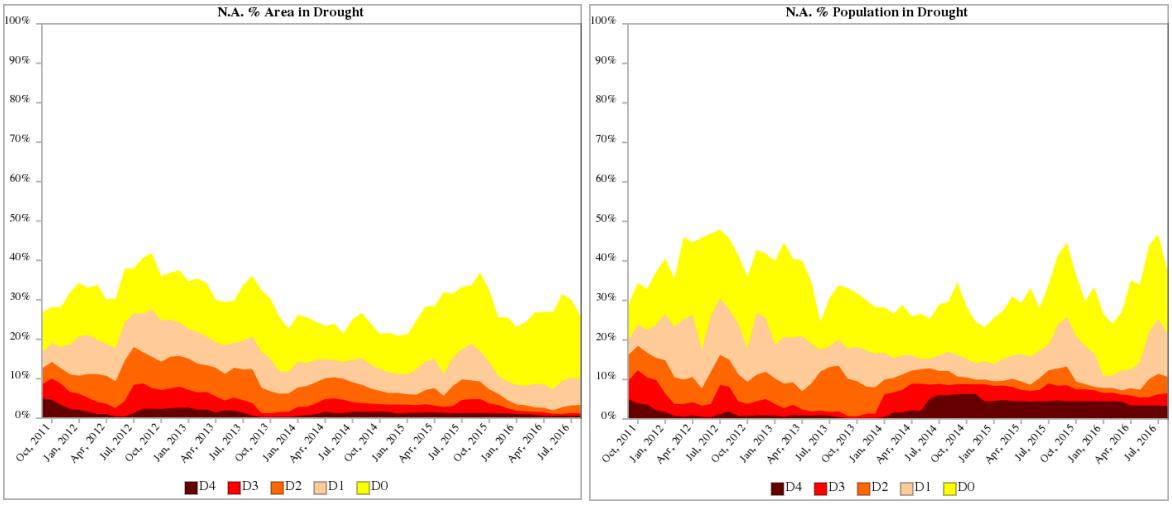
North American Drought Monitor – August 2016

At the end of August 2016, moderate to exceptional drought (D1-D4) affected approximately 10.0% of the area and 21.6% of the population of North America. The percent area value is about the same as for the end of July 2016, while the percent population value is 3.6% less than the value for the end of July.



CANADA: The month of August brought with it some much needed precipitation across parts of Canada, specifically southern and eastern Ontario and southern Québec. Precipitation in Ontario and Québec improved soil moisture conditions, but long-standing precipitation deficits and above normal temperatures for much of August resulted in continued drought. Water supplies and crop yields remained substantially below normal; these, along with crop quality have been negatively impacted. The Prairie region also received abundant rainfall eliminating all concern for drought leaving only two small regions of abnormally dry conditions. Parts of the Pacific region also experienced deteriorating conditions due to inadequate precipitation, warm temperatures and declining streamflow. As for August 31, only 7.5% of the Agricultural area in Canada had received below the 20th percentile precipitation for the growing season (April 1 to August 31).

Precipitation across the province of British Columbia for the month of August was variable, with abnormally low precipitation occurring in the southwestern, southern interior and northern coastal regions. This was especially the case for the north coast, where Canadian Forestry Services Drought Code indicated significant dryness, leading to the emergence of Severe Drought (D2) throughout the region. This developing dry pocket extended south, thus expanding the area of Abnormally Dry (D0) conditions all along the western coast towards Vancouver. Satellite-derived data and provincial hydrological drought indicator analysis also indicated anomalously dry conditions in northern parts of Vancouver Island, where the patch of Moderate Drought (D1) was extended to.

Across the Prairies, the main concern was the overabundance of precipitation throughout the month, leading to some places experiencing excessive moisture. A particularly large rain event occurred mid-month around the Edmonton region in Alberta, where upwards of

100-125 mm of rain fell. This event alleviated short-term dryness concerns, leading to the deletion of both Abnormally Dry (D0) and Moderate Drought (D1) conditions in the area. Across parts of southern Alberta, where previous drought-impacted areas existed, normal to above-normal precipitation amounts over the last 30 days helped to also alleviate most drought concerns; only a few pockets of D0 remain. However, a small patch in southeastern Saskatchewan began to appear as short-term dryness, experiencing between 40 to 85% of normal precipitation over the past 2 months. Given these short-term conditions, a small pocket of D0 was created. Northern areas of the Prairies experienced minimal change, with some added dryness in northwestern parts of Alberta and northern Manitoba, but some improvement throughout northern Saskatchewan.

Although conditions have improved slightly over the past month across Central Canada with recent precipitation, the concern of significant drought still remained. Much of Ontario continued to experience above average temperatures and large moisture deficits in eastern potions of southern Ontario as well as eastern Ontario. Unfortunately, while a large precipitation event stretching from London towards North Bay and Cornwall brought upwards of 100-200 mm of rain, other parts of southern Ontario missed much of the precipitation and thus remained in drought conditions. Low precipitation throughout eastern Ontario significantly reduced crop yields and forced farmers to purchase hay and water for their livestock as well as sell off cattle they couldn't afford to keep. The hardest hit areas stretched from Kawartha Lakes through Peterborough and Northumberland counties to Hastings and Prince Edward counties. Water supplies remained a problem throughout these areas with water wells running dry. The Lower Trent Conservation District labelled an area east of Trenton towards the Québec border as low water response Level 3 for the first time in the program's history in Ontario; this signified severe drought conditions and a water supply that no longer met demands.

Given these implications, areas in D0, D1 and D2 north of Lake Ontario stayed similar to the previous month's assessment. This significant dryness still extended into Québec, but to a lesser extent than previous analyses. Due to adequate precipitation surrounding Montréal and area, this has led to the pull back of D0 in this region. Across northern parts of Ontario and Québec, additional pockets of dry conditions emerged, given low precipitation based on Canadian Precipitation Analysis data and Canadian Forestry Service Drought Code levels.

In Atlantic Canada, areas previously showing dry conditions in Nova Scotia and Prince Edward Island in July's assessment have since deteriorated. Precipitation across the area was reported at 40-85% of normal, with the southernmost tip of Nova Scotia indicating below 40% of normal precipitation over the past 3 months. Crop conditions across Atlantic Canada in late August were extremely variable, ranging from nearly normal to almost drought-stricken. Pastures in New Brunswick and Nova Scotia were in poor condition, despite recent rains resulting in farmers having to start to feed their livestock earlier than usual. These dry conditions have resulted in the expansion of D1 conditions further south, as well as the emergence of a couple pockets of D2 in the hardest hit areas. Some of this dryness was also problematic further north across the south coast of Newfoundland, where a pocket of D0 was placed.

Drought conditions across northern parts of the country deteriorated slightly throughout August. The pre-existing Abnormally Dry (D0) pockets have amalgamated together, stretching from the Yukon Territory past Great Bear Lake in the Northwest Territories, due to low Canadian Forestry Service Drought Code as well as low streamflow levels. In addition to these dry conditions, more significant precipitation deficits were reported across southern parts of the Yukon, where a D1 was extended and D2 was created.

UNITED STATES: During August 2016, the weather over the eastern contiguous United States (CONUS) was dominated by the North Atlantic (Bermuda) High pressure system and in the Far West by the North Pacific High, while the interior West to Great Plains region fell under the influence of upper-level troughs moving in the jet stream flow. The troughs dragged cold fronts along the surface which brought cooler Canadian air masses behind them. The troughs and fronts also provided a lifting mechanism for precipitation. This circulation pattern gave the Far West and areas east of the Mississippi a warmer-than-normal month, while August was cooler than normal in the interior West and Great Plains. Record warm temperatures occurred in the Northeast. Much of the West was drier than normal due to the North Pacific High and a northwesterly jet stream flow, while the Bermuda High kept the Southeast to Mid-Atlantic Coast drier than normal. The dry weather was a factor in the development of numerous large wildfires across the West throughout the month. Rain from slow-moving cold fronts and tropical systems gave the Southern Plains to Great Lakes a wetter-than-normal month, and the summer monsoon dropped above-normal precipitation over the Southwest. Upper-level ridging, in association with the North Pacific High, produced a southerly flow which funneled moist and warmer-than-normal air into Alaska, giving the state the third warmest and 22nd wettest August in its 1925-2016 record. Several weather systems brought heavy precipitation to Hawaii during August, including Hurricane Madeline which brushed southern parts of the state at the end of the month; these systems gave the state a wetter-than-normal August. Western and northern parts of Puerto Rico were wetter than normal, but the southeast drought area had below-normal precipitation.

The fronts and upper-level dynamics associated with the troughs provided a trigger for severe weather. According to preliminary data from the NOAA National Weather Service Storm Prediction Center, 111 tornadoes occurred during August 2016, which is above the August average of 83. Most of the tornadoes occurred in the Central to Northern Plains and Midwest in association with the fronts and low pressure systems along the storm track.

The stronger-than-normal North Pacific High over the eastern North Pacific helped to deflect away from the CONUS most of the tropical cyclones which developed in the Pacific. Six named tropical cyclones (Hurricanes Lester and Madeline and Tropical Storms Howard, Ivette, Javier, and Kay) formed in the eastern tropical Pacific during August. All but Javier were steered westward by the North Pacific High's steering currents and easterly Trade winds. Tropical Storm Javier crawled north along Baja California before dissipating, but some of its moisture helped feed monsoon showers over the U.S. Southwest. With the Pacific Ocean in an ENSO-neutral state, wind shear over the Atlantic Ocean decreased which normally enhances the development of tropical systems. During August 2016, four named tropical cyclones (Hurricanes Earl and Gaston, and Tropical Storms Fiona and

Hermine) developed in the North Atlantic, along with two tropical disturbances which didn't develop into named storms. The subtropical high pressure system, which dominated the weather over the southern CONUS during much of August, interacted with these systems differently, depending on each system. Hurricane Earl originated over the Caribbean early in the month and was deflected by the subtropical high pressure system's steering currents across Mexico and away from the CONUS. Tropical Storm Fiona and Hurricane Gaston developed in the central North Atlantic and were steered away from the CONUS. Tropical Depression 8 formed in the western North Atlantic and brushed the North Carolina coast before being steered by the jet stream and a cold front away from the CONUS and further into the North Atlantic. A tropical disturbance developed early in the month in the northeastern Gulf of Mexico and impacted northern Florida. It formed beneath a part of the North Atlantic High which had few steering currents, so the disturbance slowly meandered westward along the Gulf coast, finally reaching Louisiana the week of August 14th where it dropped heavy flooding rains before being absorbed into a cold front. Another tropical disturbance, which developed over the central Atlantic the week of August 21, was steered by the North Atlantic High westward across the Lesser Antilles and then across the Greater Antilles. It reached the Gulf of Mexico, where the upper-level steering currents were weak, by the end of the month. It slowly turned north, as a front and upper-level trough moved across the eastern U.S., and intensified, reaching Tropical Storm status, on August 31st. It became Hurricane Hermine on September 1st and came ashore in northern Florida, joining with the cold front to bring heavy rain to the coastal Southeast states in early September.

With precipitation reduced by the subtropical highs, and above-normal temperatures enhancing evapotranspiration, especially in the East, drought and abnormal dryness expanded in parts of the Northern Rockies and Pacific Northwest and intensified in the Northeast. Drought contracted in Hawaii and there were areas of drought expansion and nearby contraction in the Central and Southern Plains, Southeast, and Northeast. Overall, drought contraction outweighed drought expansion, so the U.S. Drought Monitor-based national moderate-to-exceptional drought footprint decreased across the CONUS from 21.1 percent at the end of July to 19.5 percent at the end of August (from 17.7 percent to 16.3 percent for all of the U.S.). The U.S. Drought Monitor began in 2000. According to the Palmer Drought Index, which goes back to the beginning of the 20th century, about 22.1 percent of the CONUS was in moderate to extreme drought at the end of August, a slight increase compared to last month.

Historical Perspective: According to preliminary information provided by the National Centers for Environmental Information (NCEI), when precipitation is integrated across the CONUS, August 2016 ranked as the second wettest August in the 1895-2016 record with 3.47 inches (88.1 mm) of precipitation. The wettest August occurred in 1977. Record and near-record precipitation was observed across parts of the Southwest, Southern Plains, and Midwest. Louisiana had the wettest August on record and eight other states ranked in the top ten wettest category. Idaho and New Jersey were the only states ranking in the top ten driest category – each having the eighth driest August.

NCEI statistics indicated that August 2016 ranked as the 17th warmest August in the 1895-2016 record, averaging 73.6°F (23.1°C) nationwide. Eight northeast states – Connecticut,

Delaware, Maryland, Massachusetts, New Jersey, New York, Pennsylvania, and Rhode Island – were record warm, with 14 others, including Alaska, ranking in the top ten warmest category. No state ranked in the top ten coolest category. The REDTI (Residential Energy Demand Temperature Index), which is a measure of heating and cooling demand based on population degree day data, ranked second highest in the 122-year record for August, due to much-warmer-than-normal temperatures which increased cooling demand in the heavily-populated East Coast, Great Lakes, Southeast, and West Coast regions.

For the last 12 months, September 2015-August 2016 ranked as the warmest September-August period in the 1895-2016 record for Florida, Montana, North Carolina, and South Carolina, and the warmest September-August in the 1925-2016 record for Alaska. All of the states in the CONUS ranked in the top ten warmest category, with the national temperature second warmest (behind September 2011-August 2012). The last four September-August 12-month periods in California ranked in the top six warmest such periods. For the West as a whole (Rocky Mountains to West Coast), 12 of the last 17 September-August periods ranked in the top 20 warmest category. This persistent and widespread warmth has increased evapotranspiration, which has exacerbated drought. According to the Palmer Drought Index, 20% or more of the West has been in moderate to extreme drought for about three-fourths of the months since January 2000.

Agricultural and Hydrological Highlights: During August, the portion of both the U.S. corn and soybean production areas in drought decreased to about 3%, cattle inventory in drought decreased to 15%, hay production decreased to 14%, and winter wheat production decreased to 11%, all due in large part to above-normal precipitation in the central portions of the country. According to August 28th U.S. Department of Agriculture (USDA) reports, only 7% of the nation's corn crop and 7% of soybeans were rated in poor to very poor condition, but 16% of the pasture and rangeland was so rated, which are about the same as at the end of July. And 25% of the nation's topsoil moisture and 26% of the subsoil moisture were rated short to very short (dry to very dry), both improvements over last month.

On a regional basis, conditions varied and were more extreme. Fifty percent or more of the topsoil was rated by the USDA short or very short of moisture (dry or very dry) in Rhode Island (100%), Massachusetts (95%), Connecticut (80%), New Mexico (73%), California (70%), Vermont (70%), New Hampshire (66%), Delaware (66%), Nevada (65%), Oregon (62%), and Idaho (61%). Fifty percent or more of the subsoil was rated short or very short of moisture in Rhode Island (100%), Massachusetts (91%), Connecticut (89%), California (80%), Oregon (65%), Nevada (65%), New Hampshire (61%), Delaware (60%), Vermont (58%), Idaho (55%), New Mexico (55%), and Wyoming (50%).

Fifty percent or more of the pasture and rangeland was rated in poor to very poor condition in Massachusetts (88%), Rhode Island (71%), Connecticut (69%), New Hampshire (58%), Oregon (52%), and Maine (50%). Several communities and states in the Northeast issued drought watches or warnings or water restrictions during August. Streamflow and groundwater levels were low, especially in coastal New England, and reservoir levels were

below average across large parts of the West, especially in Arizona, California, Idaho, Nevada, New Mexico, Oregon, Utah, and Washington.

MÉXICO: Above-normal precipitation fell in the northern, central-north, east and southeast parts of the country in August 2015. The meteorological phenomena that provided the main rains during the month were two stationary cold fronts between Chihuahua and Coahuila; troughs in the central-north; and Tropical Storm Earl, low pressure systems and tropical waves in the southeast. The accumulated precipitation at the national level in the month of 172.1 mm was 24% or 33.4 mm above the long-term mean (1941-2015) and was classified as the ninth rainiest August.

The stationary fronts allowed exceptional rains to fall in Chihuahua and Coahuila that helped those States achieve their third and second wettest August, respectively. Rainfall in central-northern Mexico was related to the effect of troughs and helped States such as Durango, Guanajuato and Queretaro reach their fourth wettest August and Morelos reach its wettest August. In the east and southeast parts of the country, Tropical Storm Earl (2-8 August), low pressure systems, and the passage of tropical waves brought above-normal rainfall and, as a result, Quintana Roo experienced its wettest August. But Oaxaca (in the south) received only about 25 per cent of its precipitation during the month despite the passage of four tropical waves.

The summer rains have been sufficient to mitigate the drought effects observed since spring this year. In the last month, this reduction was 5 percent in coverage of moderate to extreme drought (D1-D3); as of August 31st, 16.5% of the nation was in moderate to extreme drought. The greatest recovery in drought area was observed in northern, western and central Mexico; moderate drought (D1) vanished specifically in Chihuahua, Coahuila, Durango, Zacatecas, Sinaloa, Nayarit, Guanajuato, Hidalgo, Queretaro and Mexico City. The rains also helped to eliminate dry areas (D0) in Aguascalientes, Baja California Sur, Coahuila, Morelos and Tlaxcala. However, precipitation was insufficient in the Yucatan peninsula where moderate drought (D1) increased from 3 to 12.4 percent in Quintana Roo, in addition to the increase of abnormally dry areas (D0). The drought reduction in the south of the country was less than that observed in the northern regions. In Chiapas, coverage from moderate to severe drought (D1-D2) fell from 23.9% to 7.5% but was minimal in Oaxaca (from 39.9% to 34.9%); however, extreme drought (D3) increased by 0.2% to reach 1.7% of Oaxaca in the last month. Other regions where extreme drought (D3) persists include northern Baja California and central Veracruz, covering 5% and 1% of those States, respectively. In Guerrero, moderate drought increased from 24.5% to 36.3% and severe drought from 2.5% to 5.3%.

August was warmer than normal in central-north Mexico and the Yucatan Peninsula, and near or cooler than normal in the northwest, the north (almost the entire border region with the United States), and some portions of central-south Mexico. The continuous rainfall in northern areas reduced the number of days with temperatures above 40 °C. In spite of this, the national mean temperature of 25.8°C was 2.1°C above the normal of 23.7°C and was ranked as the sixth warmest August. States such as Baja California, Colima, Hidalgo,

Michoacán and Quintana Roo reached their warmest August, according to statistics from 1971.

In August, the Ministry of the Interior issued declarations for severe rains in some municipalities of Baja California Sur, Sinaloa, Chihuahua, Coahuila, Durango, Guanajuato, Guerrero, Hidalgo, Puebla, Veracruz, Chiapas, Campeche and Quintana Roo; for flooding in Chihuahua, Guanajuato and Veracruz; and also for landslides in Veracruz. When a declaration is issued, the affected State submits claims for federal resources to face needs such as food, shelter and the health of the population affected. On the other hand, the Agri-Food Information Service and Fisheries (SIAP) reported a recovery of plantings with respect to the previous month due to the resumption of precipitation. The States benefiting most from these rains were Zacatecas, Jalisco, and Chihuahua, followed by seven more states, which together accounted for 67 percent of the cultivated areas. Agricultural production showed a decline compared to that observed in the same period of the previous season, despite the lower claims and the increase in yields. The crops most affected by losses from any meteorological phenomena were grain corn and bean, principally in the states of Zacatecas and Guanajuato, which accounted for 66.6% of the total damage reported. On the other hand, production increased in sugar cane, alfalfa green and orange in the states of Veracruz, Jalisco, Chihuahua, San Luis Potosi and Oaxaca that together account for 51.5 % of the national production of these crops.